Tractor Beams Science Fact, Not Fiction

Detection, Propulsion + Comminution of Kidney Stones with Ultrasound

Narrator: At APL-UW's Center for Industrial and Medical Ultrasound, scientists and engineers explore how to entrap and move kidney stones by deploying non-invasive acoustic waves — much like the concept of the "tractor beam" as seen on *Star Trek*.

Mike Bailey: Tractor beam is kind of a colloquial term. It doesn't sound very scientific — it sounds like science fiction. But these acoustic waves can be focused. So they can be focused beyond the stone and next to the stone. And those waves create pressure. So they can build basically a cage of pressure around the stone.

Narrator: Working in collaboration with APL-UW, Oleg Sapozhnikov of Moscow State University's physics faculty goes on to explain:

Oleg Sapozhnikov: Then when the stone or other object is in this region, then it is trapped and so if you now shift the transducer, then the stone will follow the transducer movement.

Bailey: You can kind of electronically steer that stone.

Narrator: The idea of moving and steering kidney stones attracted graduate student Mohamed Ghanem.

Mohamed Ghanem: I took Mike's acoustics class and I approached him about any exciting new research. And he introduced me to the work that was being done with developing a transducer — the tractor beam able to move objects even three dimensionally.

Narrator: For the APL-UW research team the key to acoustically steering stones with compact, user-friendly hardware is centered on an experimental transducer.

Bailey: I worked on a system when I was an undergraduate that flew on the Space Shuttle to levitate drops. Those forces have been known. But usually you need transducers from all sides holding it there. We're doing this all with one transducer.

Ghanem: He said in the email he sent me that they had 256 elements in the transducer. I hadn't seen it when I came here so I wasn't sure what he was talking about.

Narrator: Mohamed soon found out.

Ghanem: So the whole purpose of the transducer: We can apply phase delay along the surface of the transducer. And we can basically change the shape of our acoustic force, so when there's no delay there is a strong force and it's a beam. We can push things. But by changing the topology of the phase delay on the surface, we can make a doughnut shape and it can become wider and wider so we can actually capture or trap objects that are larger than the wavelength.

Barbrina Dunmire: We're further developing our technology to grab the stone and be able to drag it along the ureter. These obstructions are really the emergency conditions that drive people into the emergency room on weekends, nights, early in the morning. When the stones get stuck, there's a backflow of urine in your kidney that expands the kidney and that is what causes the pain that people experience with kidney stones.

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Narrator: Grabbing a stuck stone with a tractor beam transducer could "unstick" it.

Dunmire: We can kind of slip it down maybe into the bladder, or pull it back into the kidney and relieve that obstruction.

Ghanem: We can use it to collect debris from a kidney stone after a stone breaking procedure. There's usually debris left around. So what we can do, we can trap all the debris and we can steer it outside the kidney.

Bailey: We're working on two fronts here: A very complicated system in the lab to make exactly the beams we want and advance the most complicated best-working ones. We're also getting straight to the clinic and trying this with the existing system we've built that can push, break, and image stones.

Narrator: And next, to grab and move kidney stones with a tractor beam. Science fiction transformed to therapeutic reality.

Science at Work for You

This is APL — The Applied Physics Laboratory at the University of Washington in Seattle.